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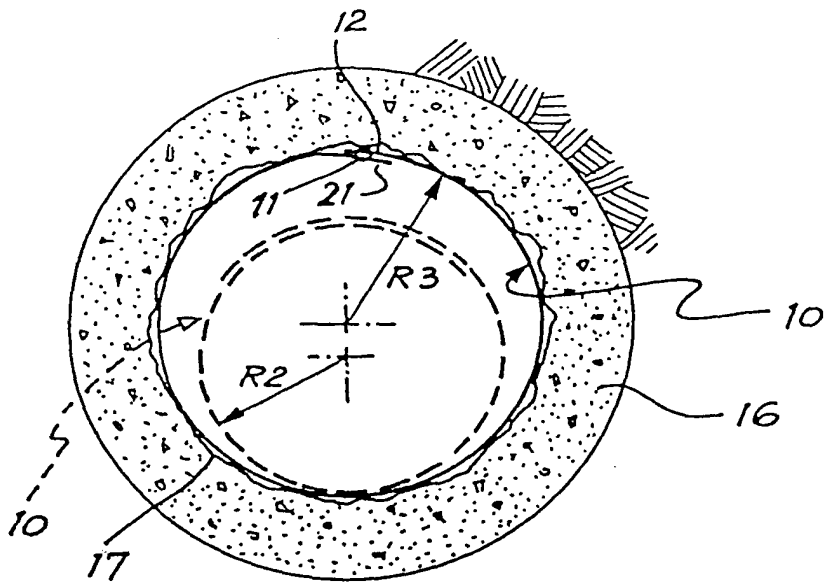

(57) Abstract

A conduit liner system comprising a length of flexurally resilient liner material (10) having first and second ends (11, 12) a first radius of curvature greater than the radius of curvature R3 of the inner surface (17) of a conduit (16) to be lined and when elastically deformed a second radius of curvature R2 smaller than that of said inner conduit surface (17) and a restraining means adapted to hold said liner at said radius R2, and wherein release of the restraining means permits said liner (10) to return to said first radius of curvature until prevented by interaction with inner conduit surface (17) provided that ends (11) and (12) overlap.

Conduit Liner

The present invention relates to the lining of conduits, in particular the in situ lining of conduits.

Conduits are often installed in physically or chemically aggressive environments which eventually leads to physical deterioration of the conduit. If such deterioration is allowed to proceed unchecked there is the danger of a structural or serviceability failure occurring. Where deterioration is discovered, the cost of in situ repairs is often less than the cost of replacement. This is particularly so in the case of culverts, storm sewers and manholes where excavation of the installation can prove to be very expensive.

One prior art method of lining a conduit is to place a conduit of outside diameter smaller than the inside diameter of the conduit to be lined within the conduit to be lined and filling any space between the two conduits with a hard settable material such as grout. This method is deficient in that many installations, such as manholes or storm sewers are of poor accessibility making it logistically impossible to install the smaller diameter conduit.

Another prior art method involves the use of metal liner components which are assembled in situ to form a conduit liner. According to this method at least one arcuate section is manufactured with a radius of curvature less than that of the inside surface of the conduit to be lined, but with a total arcuate length, greater than the circumference of the conduit to be lined and having at least one overlapping longitudinal joint. In order to provide a close fitting conduit liner, the overlap is forcibly reduced in size by a fabricated expansion means, thus increasing the net circumference and diameter of the liner until an appropriate liner diameter is attained.

This prior art method is also deficient in that

considerable work must be done, often at a poorly accessible site, to expand an assembled liner structure. Furthermore, typical liner expansion means are expensive to fabricate the metal components thus fabricated are often unsuited to a chemically aggressive environment.

According to a first aspect of the present invention there is disclosed a conduit liner system comprising:

a length of flexurally resilient liner material having first and second ends, a first radius of curvature greater than the radius of curvature of the inner surface of a conduit to be lined, and when elastically deformed a second radius of curvature smaller than that of said inner conduit surface and a restraining means adapted to hold said liner at said second radius of curvature, and wherein release of the restraining means permits said liner to return to said first radius of curvature until prevented by interaction with said inner conduit surface, and said ends overlap.

According to a second aspect of the present invention there is disclosed a method of lining a conduit comprising:

elastically deforming a length of flexurally resilient liner material, having first and second ends, being of a first undeformed radius of curvature greater than that of an internal surface of a conduit to be lined, to a second radius of curvature less than that of said conduit internal surface;

applying restraining means to said length of liner material to retain same at said second radius of curvature;

placing said elastically deformed length of flexurally resilient material within said conduit to be lined;

releasing said restraining means allowing said length of lining material to proceed to return to said first radius of curvature, complete return to said first radius of curvature being prevented by interaction of said length

of liner material with said inside surface of said conduit to be lined.

In certain embodiments of the present invention the first and second ends overlap and are secured together by a fixing means.

In the particular situation where manholes are to be lined the liner material is elastically deformed such that the second radius of curvature is small enough to allow the pieces to be passed through a manhole cover opening.

Where large diameter conduits are to be lined a plurality of pieces of flexurally resilient material may be joined first end to second end to provide the required circumference.

In a preferred embodiment, the flexurally resilient material of the present invention is obtained by longitudinally cutting a pipe manufactured from plastics material comprising helically joined ribs.

The present invention will now be described in further detail with reference to the accompanying drawings in which:-

Fig. 1A is a schematic representation of an undeformed length of flexurally resilient material.

Fig. 1B is a schematic representation of an elastically deformed length of flexurally resilient material.

Fig. 2 is a sectional view of a conduit pipe lined by a conduit liner in accordance with the present invention.

Fig. 3 is a schematic plan view of a manhole.

Fig. 4 is a view on section IV-IV of Fig. 3.

Fig. 5 is a view on section V-V of Fig. 4.

Fig. 6 is a isometric view of an embodiment of the present invention prior to locating within a conduit.

Fig. 7 is a further embodiment of the present invention.

Fig. 1a shows schematically a length of flexurally

resilient material, 10 having first and second ends 11 and 12 respectively and being of a first undeformed radius of curvature R1.

In the present embodiment the flexurally resilient length of material is elastically deformed, as shown in Fig. 1B, to a second, smaller radius of curvature R2. By applying a restraining means, such as an external annular band (not shown for clarity) the liner material may be retained in the deformed state.

In Fig. 2 it can be seen that if a second deformed radius of curvature R2 is less than the radius of curvature of the conduit to be lined R3, liner 10 (broken lines) can be disposed within conduit 16. If the restraining means retaining the second radius R2 is released, the flexurally resilient material will proceed to spring back to its original shape until prevented from so doing by interaction with the internal surface 17 of conduit 16.

The arcuate length of liner 10 is predetermined based on a calculation of the internal circumference of conduit 16 with an allowance for an overlap. Overlapping ends 11 and 12 are secured to each other by a fixing means 21 which in the present embodiment is in the form of a bead of silicone sealant.

It is also possible to use a plurality of pieces of liner material 10 to line the internal circumference of a conduit as illustrated in Fig. 5. In this example a manhole 30 of known internal radius of curvature R5 is accessed by a manhole cover opening 31 of lesser radius R4. Two pieces of liner material are elastically deformed to a radius of curvature R6 less than both radii R4 and R5 and restrained at said radius of curvature. Two such restrained pieces of liner are passed through manhole cover opening 31 and disposed within manhole 30. Upon release of the restraining means the liner pieces open out

elastically to line the internal surface 33 of manhole 30. Overlapping ends 11 and 12 are secured to each other by fixing means 21.

As illustrated in Fig. 6 restraining means 48 to prevent the length of flexurally resilient material 10 unrolling can be embodied by simple annular bands of tied tape or string however numerous other techniques, such as adhesive tapes at the terminating ends of first and second ends 11 and 12 could be employed. Alternatively lugs 50 may be located on the inner surface of the liner 10 with a tension band 52 connected therebetween. In the latter case, the subsequent release of the restraining means is easier to perform.

The lining described above can be used to line an indefinite length of conduit even if lengths of liner material of limited width L1, as shown in Fig. 6 are employed. This is done by repeating the steps described above with edge portions 34 of pieces of liner material 10 either abutting or slightly overlapping. Abutting or overlapping edges 34 are joined in the same manner as ends 11 and 12 to build up a conduit lining of indefinite length.

Any space existing between the installed liner and the conduit being repaired may be filled with a settable material. Traditional materials such as concrete or grout may be used but polyurethane, epoxy resin and silicone, being materials resistant to a chemically aggressive environment, may also be used. Polyurethane has been found to be particularly suitable for use in conjunction with the present invention.

In certain circumstances spacers (not shown) may be attached to the internal surface of the conduit to be lined. In these circumstances the liner of the present invention abuts against the spacers, rather than the actual internal conduit surface.

It has been found that a suitable liner material can be produced by longitudinally slitting a pipe made of plastics material comprising helically joined ribs. When the pipe is cut, the pipe material springs open due to unrelieved stresses within the plastics ribs. The curvature and length of the liner materials produced in this way can be controlled because the diameter of the pipe cut open will dictate the length of the pieces of liner material and careful stress relieving of the pipe before cutting can be used to control the first radius of curvature. An added advantage is that plastics materials are resistant to many chemicals that attack other conventional building materials such as steel or concrete.

Furthermore, in some cases the repair of the entire conduit circumference is not required. For example in sewers, aggressive gases attack the divert rather than the invert of a conduit. A piece of liner material 10 will support itself in the top 270° of a conduit 30 due to its natural resistance as snown in Fig. 7. Therefore the overlapping and fixing of ends 11 and 12 is not essential to the present invention. Clearly, in order for the liner 10 to remain in place in the long term fixing a same to the internal surface 33 of the conduit 30 will be required, but appropriate fixing means such as for example epoxy resins will be clear to the skilled addressee.

It will be clear to those skilled in the art that many variations can be made to the present invention without departing from the spirit and scope thereof.

Claims:

1. A conduit liner system comprising a length of flexurally resilient liner material having first and second ends, a first radius of curvature greater than the radius of curvature of the inner surface of a conduit to be lined, and when elastically deformed a second radius of curvature smaller than that of said inner conduit surface and a restraining means adapted to hold said liner at said second radius of curvature, and wherein release of the restraining means permits said liner to return to said first radius of curvature until prevented by interaction with said inner conduit surface, and said ends overlap.

2. A conduit liner system according to claim 1 including a fixing means to secure overlapping first and second ends of said length of flexurally resilient liner material together.

3. A conduit liner system as claimed in claim 1 wherein the length of liner material comprises a piece of pipe which has been slit longitudinally.

4. A conduit liner system as claimed in claim 3 wherein said pipe comprises helically joined ribs of plastics material.

5. A conduit liner system according to either claim 2 or claim 3 wherein said restraining means comprises at least one annular band or tape.

6. A conduit liner system as claimed in any one of the preceding claims wherein said fixing means comprises an elastomeric sealant.

7. A conduit lining system as any one of claims 1 to 6, comprising a plurality of lengths of liner material, wherein the combined first radius of said length is greater than the radius of curvature of said inner surface, said length being arranged in said conduit is a manner such that when the restraining means is released, the first and second ends of a liner overlap the

respective first and second ends of an adjacent liner.

8. A conduit liner system according to claim 1 including spacers in the internal surface of said conduit.

9. A method of lining a conduit comprising:

elastically deforming a length of flexurally resilient liner material having first and second ends, being of a first undeformed radius of curvature greater than that of an internal surface of a conduit to be lined, to a second radius of curvature less than that of said conduit internal surface;

applying restraining means to said length of liner material to retain same at said second radius of curvature;

placing said elastically deformed length of flexurally resilient material within said conduit to be lined;

releasing said restraining means allowing said length lining material to proceed to return to said first radius of curvature, complete return to said first radius of curvature being prevented by interaction of said length of liner material with said inside surface of said conduit to be lined.

10. A method of lining a conduit as claimed in claim 9 including applying a fixing means overlapping first and second ends of said length of liner material to secure same to each other.

11. A method of lining a conduit as claimed in either claim 9 or claim 10 wherein a plurality of lengths of liner material are joined at overlapping or abutting sides by the application said fixing means.

12. A method of lining a conduit as claimed in any of the preceding claims wherein the ends and/or sides of the liner material is fixed by the application of an elastomeric bead.

13. A conduit liner system substantially as hereinbefore described with reference to the accompanying drawings.

14. A method of lining a conduit substantially as hereinbefore described with reference to the accompanying drawings.

AMENDED CLAIMS

[received by the International Bureau on 04 January 1988 (04.01.88): original claims 1-14 replaced by new claims 1-13 (2 pages)]

1. A conduit liner system comprising a length of flexurally resilient liner (10) having first and second longitudinally extending edges (11,12) and having a first radius of curvature (R1) at least as large as the curvature required when acting as a liner and when elastically deformed a second radius of curvature (R2) smaller than that of the first radius of curvature, and a restraining means adapted to hold said liner at said second radius of curvature with said edges overlapped, and wherein release of the restraining means permits said liner (10) to return toward said first radius of curvature (R1), characterised in that the length of liner (10) is in the form of a piece of pipe which has been slit longitudinally.

2. A conduit liner (10) system as claimed in claim 1 wherein said liner is formed of a plastics material and has helically positioned strengthening ribs on at least one face.

3. A conduit liner as claimed in claim 1 or 2 wherein the liner (10) comprises a pipe formed by helically winding a ribbed strip of resilient liner material which is split longitudinally.

4. A conduit liner system according to claim 1 wherein said restraining means comprises at least one annular band or tape.

5. A conduit liner system as claimed in any one of the preceding claims wherein said fixing means comprises an elastomeric sealant.

6. A conduit lining system as in any one of claims 1 to 5, comprising a plurality of lengths of liner (10), the combined width of which defines the said first radius of curvature (R1), said liner (10) being arranged in said conduit (16) in a manner such that when the restraining means is released, the first and second edges (11,12) of a

liner (10) engage the respective first and second edges of an adjacent liner (10).

7. A conduit liner system according to claim 1 including spacers in the internal surface of said conduit.

8. A method of lining a conduit comprising:

elastically deforming a length of flexurally resilient liner (10) which is in the form of a pipe split longitudinally to have first and second longitudinally extending edges, having a first undeformed radius of curvature (R1) at least as large as the curvature required when acting as a liner, and optionally having ribs helically arranged on the said liner (10);

applying restraining means to said length of liner (10) to retain same at a smaller radius of curvature;

placing said elastically deformed length of flexurally resilient liner (10) within said conduit (16) to be lined;

releasing said restraining means allowing said length of flexurally resilient liner (10) to return toward said first radius of curvature (R1).

9. A method of lining a conduit as claimed in claim 8 including applying a fixing means overlapping first and second edges (11,12) of said length of liner (10) to secure same to each other.

10. A method of lining a conduit as claimed in either claim 8 or claim 9 wherein a plurality of lengths of liner (10) are joined at overlapping or abutting sides by the application of said fixing means.

11. A method of lining a conduit as claimed in any of the preceding claims wherein the edges (11,12) of the liner (10) are fixed by the application of an elastomeric bead.

12. A conduit liner system substantially as hereinbefore described with reference to the accompanying drawings.

13. A method of lining a conduit substantially as hereinbefore described with reference to the accompanying drawings.

AMENDED CLAIMS

[received by the International Bureau on 4 January 1988 (04.01.88);
original claims 1-14 replaced by new claims 1-13 (2 pages)]

1. A conduit liner system comprising a length of flexurally resilient liner (10) having first and second longitudinally extending edges (11,12) and having a first radius of curvature (R1) at least as large as the curvature required when acting as a liner and when elastically deformed a second radius of curvature (R2) smaller than that of the first radius of curvature, and a restraining means adapted to hold said liner at said second radius of curvature with said edges overlapped, and wherein release of the restraining means permits said liner (10) to return toward said first radius of curvature (R1), characterised in that the length of liner (10) is in the form of a piece of pipe which has been slit longitudinally.

2. A conduit liner (10) system as claimed in claim 1 wherein said liner is formed of a plastics material and has helically positioned strengthening ribs on at least one face.

3. A conduit liner as claimed in claim 1 or 2 wherein the liner (10) comprises a pipe formed by helically winding a ribbed strip of resilient liner material which is split longitudinally.

4. A conduit liner system according to claim 1 wherein said restraining means comprises at least one annular band or tape.

5. A conduit liner system as claimed in any one of the preceding claims wherein said fixing means comprises an elastomeric sealant.

6. A conduit lining system as in any one of claims 1 to 5, comprising a plurality of lengths of liner (10), the combined width of which defines the said first radius of curvature (R1), said liner (10) being arranged in said conduit (16) in a manner such that when the restraining means is released, the first and second edges (11,12) of a

liner (10) engage the respective first and second edges of an adjacent liner (10).

7. A conduit liner system according to claim 1 including spacers in the internal surface of said conduit.

8. A method of lining a conduit comprising:

elastically deforming a length of flexurally resilient liner (10) which is in the form of a pipe split longitudinally to have first and second longitudinally extending edges, having a first undeformed radius of curvature (R1) at least as large as the curvature required when acting as a liner, and optionally having ribs helically arranged on the said liner (10);

applying restraining means to said length of liner (10) to retain same at a smaller radius of curvature;

placing said elastically deformed length of flexurally resilient liner (10) within said conduit (16) to be lined;

releasing said restraining means allowing said length of flexurally resilient liner (10) to return toward said first radius of curvature (R1).

9. A method of lining a conduit as claimed in claim 8 including applying a fixing means overlapping first and second edges (11,12) of said length of liner (10) to secure same to each other.

10. A method of lining a conduit as claimed in either claim 8 or claim 9 wherein a plurality of lengths of liner (10) are joined at overlapping or abutting sides by the application of said fixing means.

11. A method of lining a conduit as claimed in any of the preceding claims wherein the edges (11,12) of the liner (10) are fixed by the application of an elastomeric bead.

12. A conduit liner system substantially as hereinbefore described with reference to the accompanying drawings.

13. A method of lining a conduit substantially as hereinbefore described with reference to the accompanying drawings.

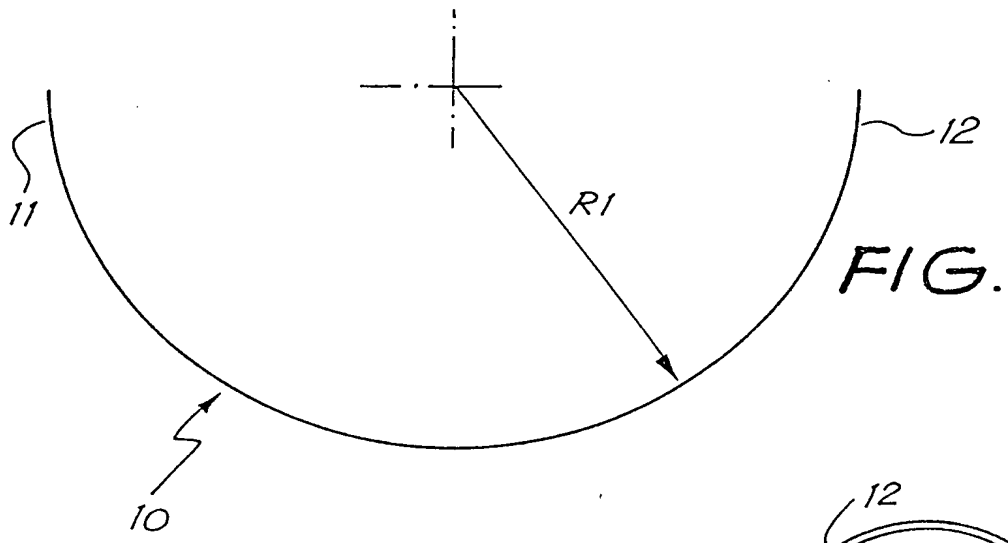

FIG. 1A

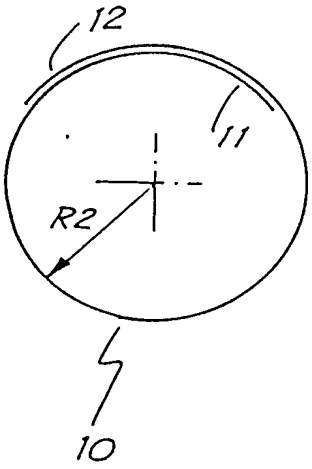

FIG. 1B

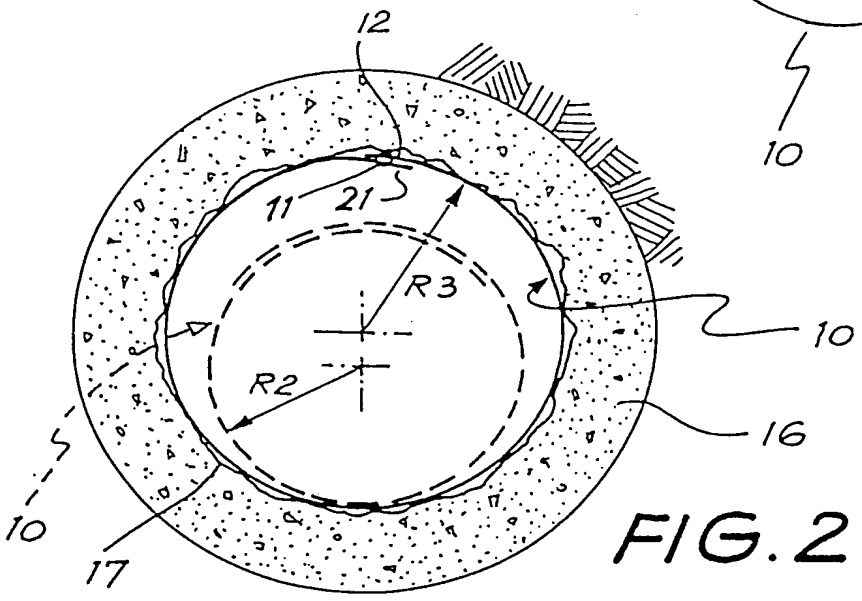

FIG. 2

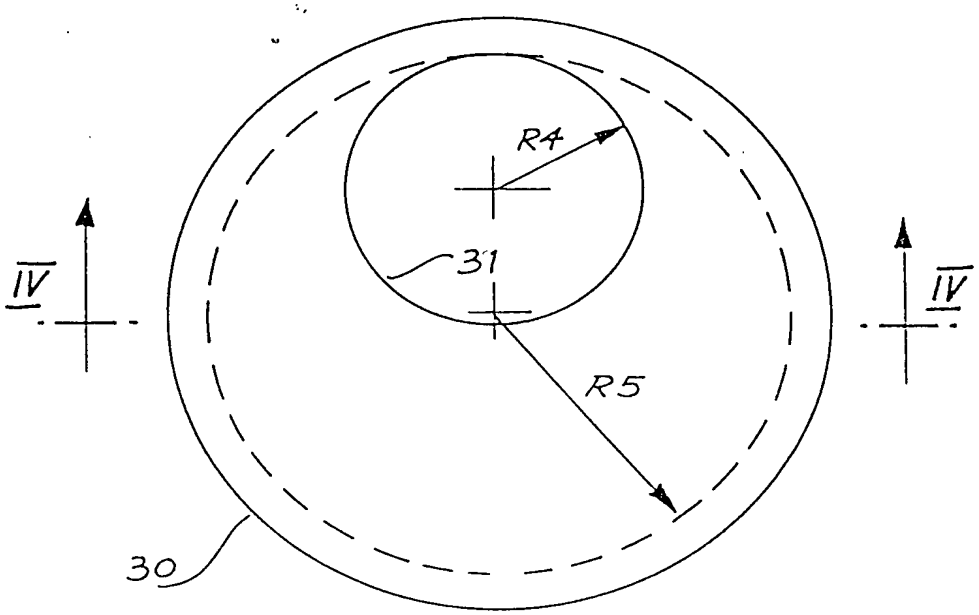

FIG. 3

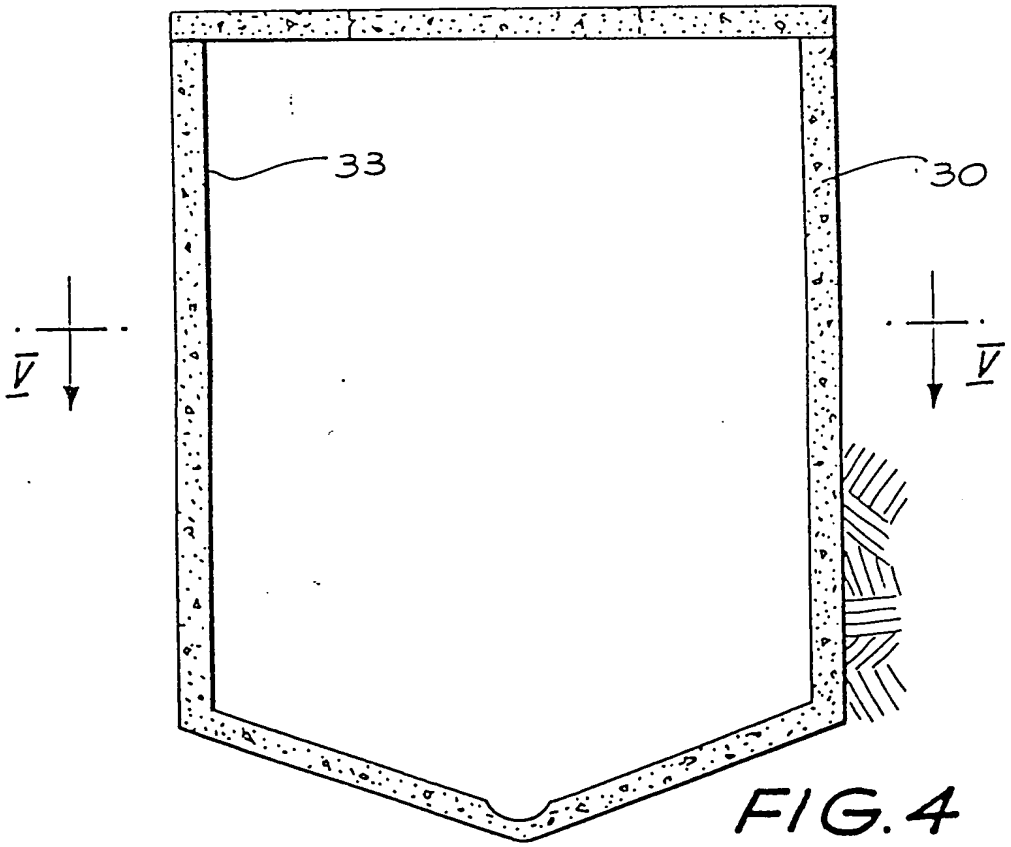

FIG. 4

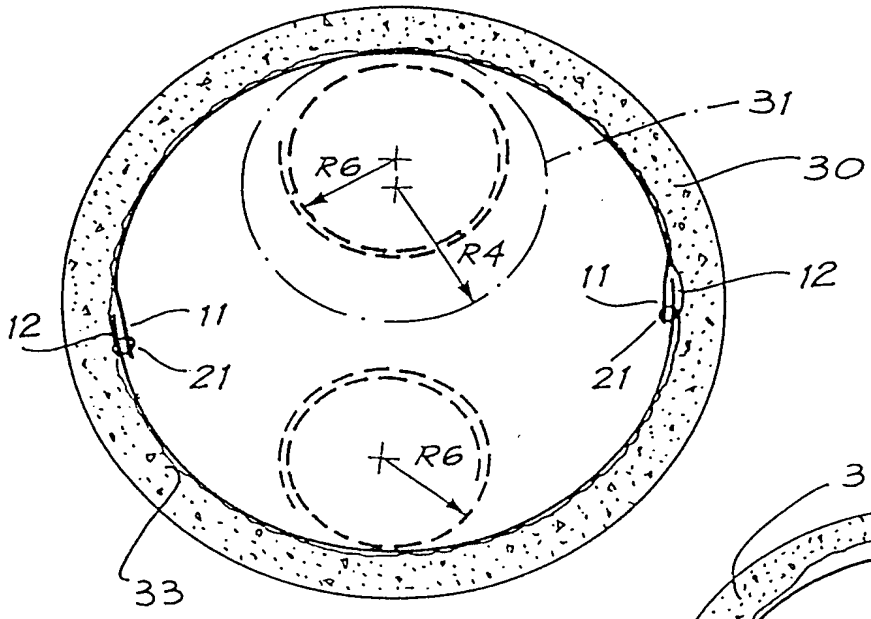

FIG. 5

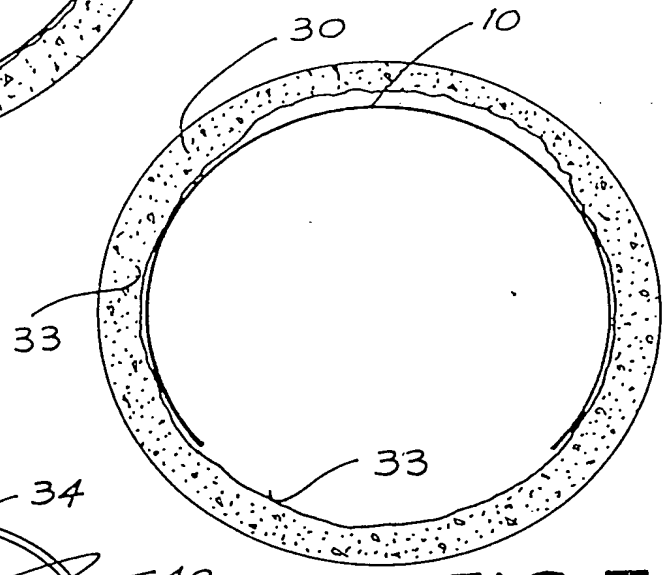

FIG. 7

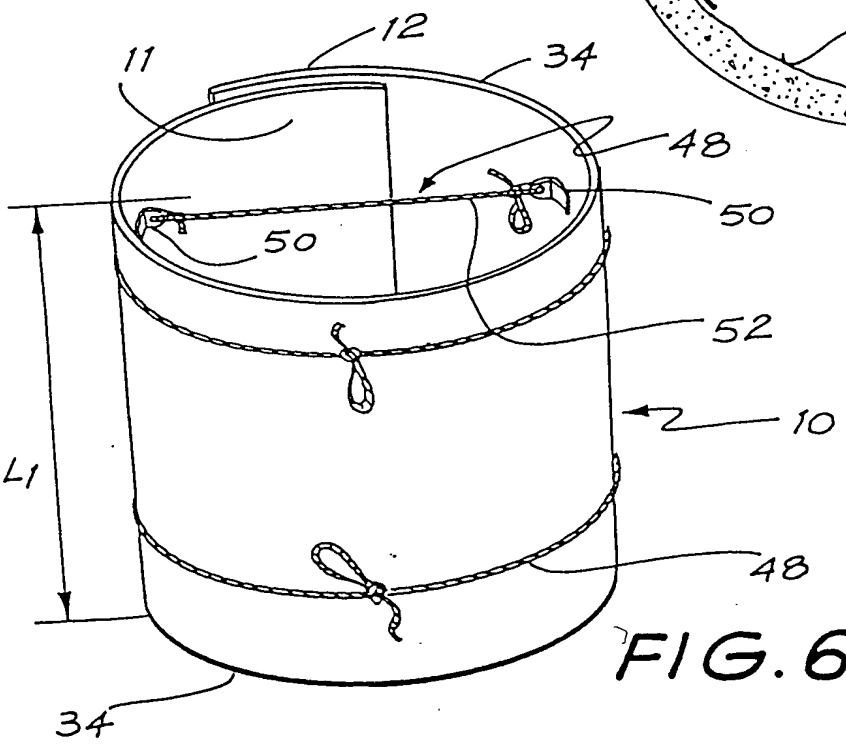

FIG. 6

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 87/00203

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[4] F16L 55/16, 55/18, 57/00, 58/10

II. FIELDS SEARCHED

Minimum Documentation Searched

Classification System	Classification Symbols
IPC	F16L 55/12, 55/16, 55/18, 57/00, 58/02, 58/10

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched

AU : IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
X	US,A, 4347018 (WRIGHTSON et al) 31 August 1982 (31.08.82)	(1-14)
X	US,A, 4109684 (FERNANDEZ) 29 August 1978 (29.08.78)	(1-3,7,9,10)
X	GB,A, 1315468 (NORTHERN ILLINOIS GAS COMPANY) 2 May 1973 (02.05.73)	(1-3)
P,X	DE,A, 3507393 (J.N. EBERLE FEDERNFABRIK GmbH) 18 September 1986 (18.09.86)	(1,2)
X	DE,B, 1177884 (J & OTTO KREBBER) 10 September 1964 (10.09.64)	(1)
X	EP,A, 0098547 (TRIO ENGINEERING LTD) 18 January 1984 (18.01.84)	(9-12)
X	US,A, 4207130 (BARBER) 10 June 1980 (10.06.80)	(9-12)
X	WO,A, 83/03131 (FORSHEDA INNOVATION AB) 15 September 1983 (15.09.83)	(9)

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
16 October 1987 (16.10.87)	(02-11-87) 2 NOVEMBER 1987
International Searching Authority	**Signature of Authorized Officer**
Australian Patent Office	for D. BUTLER

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 87/00203

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Members					
US 4347018	EP 24157	GB 2055929				
GB 1315468	CA 938231	DE 2122457	US 3678560			
EP 98547	AU 16542/83	DK 3051/83	ES 523780			
	NO 832378					
US 4207130	AT 5476/78	AU 38373/78	CA 1115917			
	DK 3324/78	EP 576	ES 472063			
	GB 2003576	NO 782548				
WO 8303131	AU 12295/83	DK 4982/83	EP 101712			
	FI 833967	NO 833649	SE 8201259			

END OF ANNEX